

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
CHAPTER 12 RADIATION PROTECTION.....		12.1-1
12.1 Assuring that Occupational Radiation Exposures Are As-Low-As-Reasonably Achievable (ALARA).....		12.1-1
12.1.1 Policy Considerations		12.1-1
12.1.1.1 Design and Construction Policies.....		12.1-1
12.1.1.2 Operation Policies		12.1-1
12.1.1.3 Compliance with 10 CFR 20 and Regulatory Guides 1.8, 8.8, and 8.10		12.1-1
12.1.2 Design Considerations		12.1-2
12.1.2.1 General Design Considerations for ALARA Exposures		12.1-2
12.1.2.2 Equipment General Design Considerations for ALARA.....		12.1-3
12.1.2.3 Facility Layout General Design Considerations for ALARA		12.1-5
12.1.2.4 Equipment and Facility Layout General Design Considerations for 10 CFR 20.1406.....		12.1-6
12.1.3 Combined License Information.....		12.1-7
12.2 Radiation Sources.....		12.2-1
12.2.1 Contained Sources		12.2-1
12.2.1.1 Sources for Full-Power Operation.....		12.2-1
12.2.1.2 Sources for Shutdown		12.2-4
12.2.1.3 Sources for the Core Melt Accident		12.2-5
12.2.2 Airborne Radioactive Material Sources		12.2-6
12.2.2.1 Containment Atmosphere.....		12.2-6
12.2.2.2 Fuel-Handling Area Atmosphere.....		12.2-6
12.2.2.3 Auxiliary Building Atmosphere		12.2-6
12.2.2.4 Airborne Activity Model		12.2-7
12.2.3 Combined License Information.....		12.2-7
12.2.4 References.....		12.2-8
12.3 Radiation Protection Design Features		12.3-1
12.3.1 Facility Design Features.....		12.3-1
12.3.1.1 Plant Design Features for ALARA.....		12.3-1
12.3.1.2 Radiation Zoning and Access Control.....		12.3-8
12.3.2 Shielding.....		12.3-9
12.3.2.1 Design Objectives		12.3-9
12.3.2.2 General Shielding Design.....		12.3-9
12.3.2.3 Shielding Calculational Methods		12.3-14
12.3.3 Ventilation		12.3-15
12.3.3.1 Design Objectives		12.3-15
12.3.3.2 Design Criteria		12.3-15
12.3.3.3 Design Features		12.3-15
12.3.3.4 Design Description.....		12.3-17
12.3.3.5 Air Filtration Units		12.3-17

TABLE OF CONTENTS (Cont.)

<u>Section</u>	<u>Title</u>	<u>Page</u>
12.3.4	Area Radiation and Airborne Radioactivity Monitoring Instrumentation	12.3-18
12.3.5	Combined License Information..... 12.3.5.1 Administrative Controls for Radiological Protection 12.3.5.2 Criteria and Methods for Radiological Protection 12.3.5.3 Groundwater Monitoring Program 12.3.5.4 Record of Operational Events of Interest for Decommissioning.....	12.3-18 12.3-18 12.3-18 12.3-19 12.3-19
12.3.6	References.....	12.3-19
12.4	Dose Assessment.....	12.4-1
12.4.1	Occupational Radiation Exposure..... 12.4.1.1 Reactor Operations and Surveillance..... 12.4.1.2 Routine Inspection and Maintenance 12.4.1.3 Inservice Inspection..... 12.4.1.4 Special Maintenance 12.4.1.5 Waste Processing..... 12.4.1.6 Fuel Handling..... 12.4.1.7 Overall Plant Doses..... 12.4.1.8 Post-Accident Actions.....	12.4-1 12.4-2 12.4-2 12.4-2 12.4-3 12.4-3 12.4-3 12.4-3 12.4-4 12.4-4
12.4.2	Radiation Exposure at the Site Boundary	12.4-5
	12.4.2.1 Direct Radiation	12.4-5
	12.4.2.2 Doses due to Airborne Radioactivity.....	12.4-5
12.4.3	Combined License Information.....	12.4-5
12.5	Health Physics Facilities Design	12.5-1
12.5.1	Objectives	12.5-1
12.5.2	Equipment, Instrumentation, and Facilities..... 12.5.2.1 Access and Exit of Radiologically Controlled Areas..... 12.5.2.2 Facilities	12.5-1 12.5-1
	12.5.2.3 Whole Body Counting Instrumentation..... 12.5.2.4 Portable Survey Instrumentation	12.5-2 12.5-2
	12.5.2.5 Other Health Physics Instrumentation	12.5-2
12.5.3	Other Design Features..... 12.5.3.1 Radiation Protection Design Features	12.5-3
	12.5.3.2 Job Planning Facilities	12.5-3
	12.5.3.3 Radwaste Handling	12.5-3
	12.5.3.4 Spent Fuel Cask Loading and Shipping	12.5-3
	12.5.3.5 Normal Operation.....	12.5-3
	12.5.3.6 Sampling	12.5-4
	12.5.3.7 Surface Coatings	12.5-4
12.5.4	Controlling Access and Stay Time.....	12.5-4
12.5.5	Combined License Information.....	12.5-4

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
12.2-1	Radiation Flux at The Primary Shield Concrete.....	12.2-9
12.2-2	Core Average Gamma Ray Source Strengths at Various Times After Shutdown (Sheets 1 – 2).....	12.2-10
12.2-3	Reactor Coolant Nitrogen-16 Activity.....	12.2-12
12.2-4	Pressurizer Nitrogen-16 Source Strengths.....	12.2-13
12.2-5	Pressurizer Liquid and Steam Phase Source Strengths and Specific Activity (Sheets 1 – 4).....	12.2-14
12.2-6	Isotopic Composition and Specific Activity of Typical Out-of-Core Crud Deposits.....	12.2-18
12.2-7	Chemical and Volume Control System Components Source Strengths and Specific Activity (Sheets 1 – 8).....	12.2-19
12.2-8	Spent Fuel Pool Cooling System Component Source Strengths and Specific Activity.....	12.2-27
12.2-9	Liquid Radwaste System Component Source Terms (Sheets 1 – 7).....	12.2-28
12.2-10	Gaseous Radwaste System Component Source Terms (Sheets 1 – 4).....	12.2-35
12.2-11	Spent Demineralizer Resin Source Strengths and Specific Activities (Sheets 1 – 2)	12.2-39
12.2-12	Normal Residual Heat Removal System Source Strengths and Specific Activities (Sheets 1 – 2)	12.2-41
12.2-13	Core Average and Spent Fuel Neutron Source Strengths at Various Times After Shutdown	12.2-43
12.2-14	Spent Fuel Gamma Ray Source Strengths (Sheets 1 – 2).....	12.2-44
12.2-15	Irradiated Silver-Indium-Cadmium Control Rod Source Strengths.....	12.2-46
12.2-16	Irradiated SB-BE Secondary Source Rod Gamma Ray Source Strengths	12.2-47
12.2-17	Irradiated SB-BE Secondary Source Rod Neutron Source Strengths	12.2-48
12.2-18	Irradiated Stainless Steel Source Strengths (0.12 Weight Percent Cobalt).....	12.2-49
12.2-19	Irradiated Flux Thimble Source Strengths.....	12.2-50
12.2-20	Core Melt Accident Source Strengths In Containment Atmosphere as a Function of Time.....	12.2-51
12.2-21	Core Melt Accident Integrated Source Strengths In Containment Atmosphere	12.2-52
12.2-22	Parameters and Assumptions Used for Calculating Containment Airborne Radioactivity Concentrations	12.2-53
12.2-23	Containment Airborne Radioactivity Concentrations (Sheets 1 – 3).....	12.2-54
12.2-24	Parameters and Assumptions Used for Calculating Fuel Handling Area Airborne Radioactivity Concentrations	12.2-57
12.2-25	Fuel Handling Area Airborne Radioactivity Concentrations (Sheets 1 – 2).....	12.2-58
12.2-26	Parameters and Assumptions Used for Calculating Auxiliary Building Airborne Radioactivity Concentrations	12.2-60
12.2-27	Auxiliary Building Airborne Radioactivity Concentrations (Sheets 1 – 3)	12.2-61
12.3-1	Equipment Specification Limits for Cobalt Impurity Levels.....	12.3-21

LIST OF TABLES (Cont.)

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
12.4-1	Dose Estimate for Reactor Operations and Surveillance	12.4-6
12.4-2	Dose Estimate for Routine Inspection and Maintenance	12.4-7
12.4-3	Dose Estimate for Reactor Coolant Pump Inspection.....	12.4-8
12.4-4	Dose Estimate for Sludge Lancing of Steam Generators.....	12.4-9
12.4-5	Dose Estimate for Visual Examination of Steam Generator Secondary Side	12.4-10
12.4-6	Dose Estimate for Inservice Inspection	12.4-11
12.4-7	Dose Estimate for Steam Generator Eddy Current Tube Inspection and Tube Plugging (Sheets 1 - 2).....	12.4-12
12.4-8	Dose Estimate for Steam Generator Inservice Inspection (10-Year Interval) (Sheets 1 - 2)	12.4-14
12.4-9	Dose Estimate for Special Maintenance Operations.....	12.4-16
12.4-10	Dose Estimate for Waste Processing	12.4-17
12.4-11	Design Improvements that Reduce Refueling Doses.....	12.4-18
12.4-12	Dose Estimate for Refueling Activities	12.4-19

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
12.3-1	Radiation Zones, Normal Operation/Shutdown Legend (Sheet 1 of 16)	12.3-22
12.3-1	Site Radiation Zones, Normal Operations/Shutdown (Sheet 2 of 16)	12.3-23
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 66'-6" (Sheet 3 of 16).....	12.3-25
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 82'-6" (Sheet 4 of 16).....	12.3-27
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 96'-6" (Sheet 5 of 16).....	12.3-29
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 100'-0" & 107'-2" (Sheet 6 of 16)	12.3-31
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 117'-6" (Sheet 7 of 16).....	12.3-33
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 135'-3" (Sheet 8 of 16).....	12.3-35
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 153'-0" & 160'-0" (Sheet 9 of 16)	12.3-37
12.3-1	Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 160'-6" & 180'-0" (Sheet 10 of 16)	12.3-39
12.3-1	Radiation Zones, Normal Operations/Shutdown Annex Building, Elevation 100'-0" & 107'-2" (Sheet 11 of 16)	12.3-41
12.3-1	Radiation Zones, Normal Operations/Shutdown Annex Building, Elevation 117'-6" & 126'-3" (Sheet 12 of 16)	12.3-43
12.3-1	Radiation Zones, Normal Operations/Shutdown Annex Building, Elevation 135'-3", 146'-3", 156'-0" & 158'-0" (Sheet 13 of 16).....	12.3-45
12.3-1	Radiation Zones, Normal Operations/Shutdown Radwaste Building, Elevation 100'-0" (Sheet 14 of 16)	12.3-47
12.3-1	Radiation Zones, Normal Operations/Shutdown Turbine Building, Elevation 100'-0" (Sheet 15 of 16)	12.3-49
12.3-1	Radiation Zones, Normal Operations/Shutdown Turbine Building, Elevation 117'-6" (Sheet 16 of 16)	12.3-51
12.3-2	Radiation Zones, Post-Accident Legend (Sheet 1 of 15).....	12.3-53
12.3-2	Site Radiation Zones, Post-Accident (Sheet 2 of 15)	12.3-55
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 66'-6" (Sheet 3 of 15).....	12.3-57
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 82'-6" (Sheet 4 of 15).....	12.3-59
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 96'-6" (Sheet 5 of 15).....	12.3-61
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 100'-0" & 107'-2" (Sheet 6 of 15).....	12.3-63

LIST OF FIGURES (Cont.)

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 117'-6" (Sheet 7 of 15).....	12.3-65
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 135'-3" (Sheet 8 of 15).....	12.3-67
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 153'-0" & 160'-6" (Sheet 9 of 15).....	12.3-69
12.3-2	Radiation Zones, Post-Accident Nuclear Island, Elevation 160'-6" & 180'-0" (Sheet 10 of 15).....	12.3-71
12.3-2	Radiation Zones, Post-Accident Annex Building, Elevation 100'-0" & 107'-2" (Sheet 11 of 15).....	12.3-73
12.3-2	Radiation Zones, Post-Accident Annex Building, Elevation 117'-6" & 126'-3" (Sheet 12 of 15).....	12.3-75
12.3-2	Radiation Zones, Post-Accident Annex Building, Elevation 135'-3", 146'-3", 156'-0" & 158'-0" (Sheet 13 of 15).....	12.3-77
12.3-2	Radiation Zones, Post-Accident Radwaste Building, Elevation 100'-0" (Sheet 14 of 15).....	12.3-79
12.3-2	Radiation Zones, Post-Accident Turbine Building, Elevation 100'-0" (Sheet 15 of 15).....	12.3-81
12.3-3	Radiological Access Controls Legend (Sheet 1 of 16).....	12.3-83
12.3-3	Site Radiation Access Controls, Normal Operations/Shutdown (Sheet 2 of 16).....	12.3-85
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 66'-6" (Sheet 3 of 16)	12.3-87
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 82'-6" (Sheet 4 of 16)	12.3-89
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 96'-6" (Sheet 5 of 16)	12.3-91
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 100'-0" & 107'-2" (Sheet 6 of 16)	12.3-93
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 117'-6" (Sheet 7 of 16)	12.3-95
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 135'-3" (Sheet 8 of 16)	12.3-97
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 153'-0" & 160'-6" (Sheet 9 of 16)	12.3-99
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 160'-6" & 180'-0" (Sheet 10 of 16)	12.3-101
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Annex Building, Elevation 100'-0" & 107'-2" (Sheet 11 of 16)	12.3-103
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Annex Building, Elevation 117'-6" & 126'-3" (Sheet 12 of 16)	12.3-105

LIST OF FIGURES (Cont.)

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Annex Building Elevation 135'-3", 146'-3", 156'-0" & 158'-0" (Sheet 13 of 16).....	12.3-107
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Radwaste Building, Elevation 100'-0" (Sheet 14 of 16)	12.3-109
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Turbine Building, Elevation 100'-0" (Sheet 15 of 16)	12.3-111
12.3-3	Radiological Access Controls, Normal Operations/Shutdown Turbine Building, Elevation 117'-6" (Sheet 16 of 16)	12.3-113